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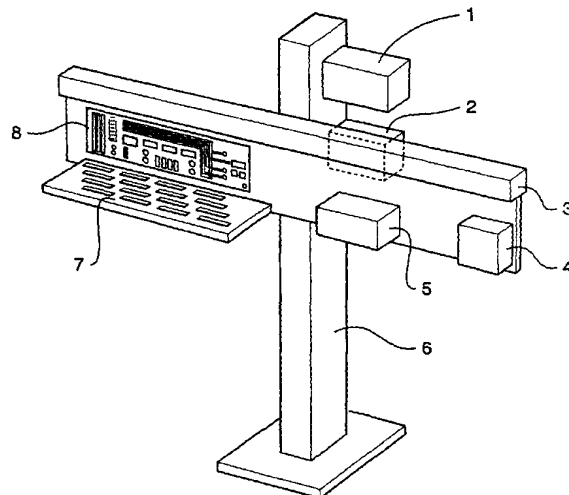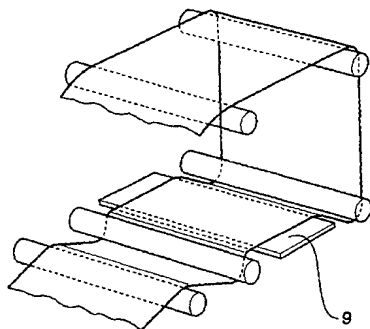
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(54) Title: MULTI LAYER CONTINUOUS PAPER PRINTER

(57) Abstract: A method of printing that enables simultaneous printing multiple paper streams with a combination of fixed and variable information is disclosed. The method is useful in combination with high-speed form collators handling multiple paper streams. The method uses a web based graphics editor program to develop page layout information incorporating fixed and variable image information using a web based graphics editor program. The page layout information is manipulated by an image processing computer, said image processing computer including a digital signal processing system adapted to analyse the page layout information into a pixel data corresponding to fixed and variable information to be printed and dividing the pixel data into a plurality of data packets. The data packets are delivered to a respective print head in a plurality of print head arrays. Each of the print head arrays is associated with a separate paper stream to thereby produce printing on multiple streams simultaneously.

Multi Layer Continuous Paper Printer

BACKGROUND OF THE INVENTION

Field of the invention

The present invention relate to a multi-layer continuous paper printer and printing system.
5   In particular, the present invention relates to a printing system adapted to produce multi-
page booklets in which each page of the booklet contains a combination of fixed and
variable information. Typically, the printing system of the present system would be used
for printing commercial material, for example, multi-layer consignment notes using goods
transportation.

10   **Brief Description of the Prior Art**

Printing technology using electro-optical techniques which reproduce information from an
original document sheet is well known. Such a system is described in US Patent No.
5742879 (Eastman Kodak Company). This US patent describes the creation of a digitised
master from which a set of copies may be made and reproduction apparatus for providing
15   reproductions of the original document template with both constant and variable
information panels in the document. Typically, the master would be generated using an
optical system, and a second image containing the variable information would be produced
and the images fused to form a composite master having both the variable and the
constant information therein.

20   Similarly, digital printing systems are known, see for example United States Patent No.
5875288 in which a digital representation of an image is reproduced from a storage device
and ultimately printed. The patent describes screen based methods of arranging digital
representations in accordance with their desired plate layout to define a plate image, the
apparatus having associated with the press control apparatus for automatically monitoring
25   the printed output of the printing press and automatically providing adjustment to printing
registration and ink flow controls. Such a system is adapted for amending and refinement
of a colour image without the need to produce each of the separate colour separations
traditionally required in colour printing.

The present invention is directed to an alternative digital printing system which allows the merging of fixed printing information and variable printing information which, in combination with mechanical printing operations allows the production of large number of individual multi-page booklets, each booklet containing a unique combination of fixed and variable
5   information.

Summary of the invention

Therefore, according to first aspect of the present invention, there is provided a method of simultaneously printing multiple paper streams with a combination of fixed and variable information, characterised in that said method comprises the steps of:
10   -developing page layout information incorporating fixed and variable image
                information using a web based graphics editor program;
                -supplying the page layout information to an image processing computer, said
                image processing computer including a digital signal processing system adapted to
                analyse the page layout information into a pixel data corresponding to fixed and
15   variable information to be printed and dividing the pixel data in to a plurality of data
                packets; and
                - each of said data packets being delivered to a respective print head in a plurality
                of print head arrays, wherein a respective print head array corresponds to each
                layer of paper to be printed.

20   Thus, by taking the page layout information, which is produced in digital form the image processing computer is able to translate the information into discrete data packets that correspond to the printed information to appear on each of the layers in the final product and deliver data packets at the appropriate times to each of the print heads in each of the print head arrays to produce the final product having a combination of fixed and variable
25   information on each layer.

The print method of the present invention is particularly suited for use with form collators adapted to handle multiple paper streams simultaneously.

Preferably, the page layout information is stored on a main server as a print job by a job server program which is adapted to implement a version control scheme and organise
30   storage and updates of designs.

Preferably, the print job information is accessed from the job server at a printer operator station networked to the main server. The printer operator station preferably uses a printer control program operating in a web browser or in a JAVA Runtime Environment. The printer operator station can preferably interrogate the job server via a menu system for a

5   list of jobs to be printed and select a job for printing. The printer operator program prompts the job server to forward the page layout information to the image processing computer and control electronics associated with the print head arrays.

Preferably, each print head array is mounted on an adjustable platform creating a modular print station. Each print station is conveniently able to be movably mounted on a monorail

10   so that the print station can be positioned at any suitable length along the printer. Further, the print head array is adjustable in two directions, allowing the print station to handle a variety of paper positions. A set-release-reset mechanism incorporated into the positioning mechanism for the print head array permits rapid servicing and precise repositioning of the print head array in the print station. The print station and monorail assembly can be

15   attached to a form collator, each print station and print head array having a respective paper stream. In such a case each paper stream has a respective page layout and the image processing computer is able to create data packets that for each print head array, and within the print head array for each print head.

In a preferred form of the invention, the print head array includes a plurality of inkjet

20   devices, a processor controlled power supply, and an ink supply system.

Preferably, each of the modular print stations and accordingly the print head arrays has a communications link to the pixel processing computer and an operator station associated with an interactive with the image processing computer. More preferably still, the image processing computer interacts with a main server through a graphical user interface.

25   In one form of the invention both the printer operator program and the graphic editor used for the page layout design are programmed using a common programming language, for example, the JAVA language, to ensure that user interfaces are consistent. Thus, the common language can be used to describe print jobs for both the operator of the graphic editor and for the printer operator.

30   The graphic editor allows the creator to assemble up to 8 separate layers for any print job. The use of a screen object allows the creator to establish a parcel of information, given the name a data object, to be printed which can be placed in any location on one layer, copied

in a different location in that layer and duplicated on subsequent layers in any specified location.

BRIEF DESCRIPTION OF THE DRAWINGS

5   The present invention will no be described, by way of example only, with reference the accompanying drawings in which:

FIG 1 illustrates schematically a printing system in accordance with one embodiment of the present invention;

FIG 2 illustrates a print head array used in the printing system of the present invention;

10   FIG 3 illustrates a print head mount used to hold the print head array of FIG 2;

FIG 4 illustrates the paper stream around the print head; and

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The operation of the print system of the present invention can be separated into a number of constituent elements of the process. In particular embodiment under consideration here

15   the system of the present invention is used in connection with the design and printing of a multi-layer consignment note including fixed and variable information on separate layers.

1.   Graphics design

The graphics design program is conveniently written in the JAVA language and is typically operated through a web browser. The design program is down loaded by the graphic

20   designer form the main serve via an internet link.

The graphic designer interacts with the graphic editor program which is a client of two main serve activities; the job server and the font server. The page layout designs are stored on the main server by the job server program which implements a version control scheme to organise storage and updates of the designs.

The protocol employed between the graphics editor program in the main server operate as follows:

i.   The graphics editor program interrogates the job server program for a list of jobs available for editing or viewing. The information is provided to the user via a menu system and an existing job may be selected and loaded for editing.

ii.   When the editing is complete the graphics editor program can instruct the job server program to save the current design. The job servers version control system provides the designer with an incremented minor release number to uniquely identify the updated version, that is by a new version ID number. Alternatively, the user may branch the design work to a new major ID number. Confirmation of the design save operation is completed by using a graphical user interface and all attributes describing the saved job are stored in a standard description file.

iii.   The graphics editor program interrogates the font server program for a list of available fonts to display to the graphics designer. An appropriate font is selected by the designer, including all of the necessary attributes which may be presented to the designer through a graphical user interface. The font server generates the font at the desired height and supplies pixel data relating to the font to the graphics editor program using an open standard image format.

iv.   The graphic editor program can subsequently interrogate the job server program to create an image to be used as background material in the design.

It should be noted that existing or stored versions of designs can be loaded for further work. Access to any designs may be based on appropriate security protocols including user name and password. Further security devices can include a standard firewall operation available through the main server.

In creating a new design a designer is presented with a number of options which allow the selection of desired page size, page orientation in relation to the flow of paper stock on the printer and the number of layers in the final product. Page sizes would be measured in typically available standard units with a default of inches using the direction of paper flow and a default of centimetres used perpendicular to paper flow. Having selected the desired paper orientation the design is then able to choose from a number of printing resolutions in the paper flow direction, typically measured in dots per inch.

The graphics design program further allows the page layout design process to be completed through the web browser software. The graphics designer composes a design by selecting and positioning screen objects and attaching to those objects information in the form of data objects. The data objects may be selected from an object library

5   containing fixed text, variable text, counters and images. There are four important data types normally under consideration, these including:-

-Changing text such as may be used for retrieving information from databases. This type of information can be used for mass mailings, where the names and addresses of the people concerned are stored in a database. Another use is in the printing of a database of

10   customer generated numbers, where the customer is sensitive to the calculation method becoming known.

- Counters used to generate numbers based on a formula. In this case the person doing the layout enters parameters such as the counter increment, the number of check digits and the check digit method. This information is then used by the printing program to create

15   numbers to be used for invoices, delivery dockets and the like, where a sequential numbering scheme is used, possibly with a check method.

- Constant text is used where a string of text will remain the same throughout a printing job. This text may be the company name, a telephone number or any other string of numbers and characters.

20   - Constant images, for example, company logos.

As each object is selected from the menu and positioned on the screen the designer is asked to specify various attributes in secondary menus. Fixed text is immediately specified. Variable text is given a database tag name. Counters have first, last and increment values entered. All text objects have attributes such as font name and font size

25   chosen from additional menus which are generated on line from the main server which serves font data over the network. Background images are obtained through use of a scanner or by using a suitable drawing package. The designer is able to group together existing objects in a design to form new objects called composite objects.

2.   The Printer Operator Station

The printer operator station involves a separate software system to the graphic design software, however the two software systems are able to inter communicate. The printer operator station is designed to allow the operator to interact with the pixel processing computer and the main computer reserve and the factor network.

5   The printer operator therefore works at a computer that uses a printer control program downloaded over the computer network from the main server. The operator program has been written in the JAVA language and can be operated in a web browser or the JAVA runtime environment (JRE). One the printer operator station is running the following actions are possible:

10   i.   The printer operator program can interrogate the job server program for a list of jobs that are available for printing and this information can be supplied to the printer operator by a menu system.

       ii.   A job to be printed is selected and the printer operator program is then able to request the job server to forward all necessary information for the operator program, the
15   pixel processing computer and the control electronics in the printing stations.

       iii.   During the printing operation the printer operator is responsible for starting and stopping the system whilst attending to replenishment of paper and ink inputs to the printer.

       The modular printing system is illustrated in figs 1-4 and includes a power supply q, height adjusting apparatus 2 and linear tracking equipment 3. Inkjet printing is carried out by the
20   print head array 7 which is supplied with ink from a supply distributor 5 from an ink supply 4. The printing station is supported on a pedestal 6 and is operatively associated with a print station 9.

       3.   The Paper Path

       The paper path is illustrated at the print station 9 in Figure 1 which indicates the paper reel
25   9a, the main tension roller 9b, subsequent tension rollers and four rollers 9c which stabilise the paper near the print heads 7. The side elevation shown in fig 4 further illustrates the feed rollers that carry the paper down onto the traction feed conveyor system.

       The paper path from the source reel to the print heads contains a tension roller arrangement to ensure that eh paper between the printing station and the main paper ·

chopper is maintained under tension. A tight paper web improves accuracy in positioning the printed in the direction of paper flow. There are four rollers located 9c at the corners of a box that encapsulates the print head assembly. These rollers 9c ensure a uniform paper flow in the vicinity of the print heads thereby improving output, quality by minimising image

5   drift in the direction perpendicular to paper flow, which is caused by paper creep.

4.   Modular printing stations

Modular printing stations are mounted on a mono rail system in the form of linear track 3 that traverses the full length of the printer allowing individual stations to be repositioned at any paper feed point. Should an of the units fail they can easily be replaced with nearly

10   spares by moving the stations along the mono rail.

The number of active modular printing stations in any particular job is chosen according to the number of pages required in the print job. For example, a printed product containing four pages that would have been assembled by four active modular printer stations stacked end to end with the unit nearest to the chopper supplying the top layer and the unit furthest

15   form the chopper producing the bottom layer.

Because the modular units are cascaded out across the printing are athe paper path from the print head assembly associated with each unit to the final chopping stage varies. This ensures that each unit is printing a different version of the product at any selected time, in anticipation of the different paper flow delays from the print head to chopper, so that the

20   final sheets correspond to one another. That is that counters match multi-layer variable text matches and so.

5.   Print Head Assembly

A precision machined plate holds 10 each head 11 in a head carrier facing along the direction of paper travel. Two bolts attach the print head to a carrier and the two bolts then

25   attach the carrier and print head to the precision machined plate. A milling regime is employed to minimise warping of the plate.

The print heads are tightly packed in the mounting plate in order to reduce their spacing along the direction of paper flow.

The print head assembly is fixed to a horizontal slider arm that is connected to a vertical post mounted on a mono rail platform. In order to carry out maintenance to the print head full access to the plumbing and electrical connections of the individual print heads is necessary. The slider assembly allows the print head assembly to move from a print

5   position, where the heads are held above and across the paper, to a maintenance position, where the heads and supporting electronics are fully accessible. The slider arm also features adjustable limits on movement, with locking nuts to ensure that the print head position over the paper can be set and easily regained after maintenance. A dampened compressed air ram controls the vertical height of the slider.

10   The mono rail system that supports the printing station allows it to be readily moved to any position along the length of the printer. This allows printing to be performed at non standard locations and also allows a printing station to replace a damaged or failed printing station.

       6.   Paper movement sensing

15   A shaft encoder or encoders generate a signal in proportion to paper position such that the pixel processor computer can determine the time instance at which to fire the print heads. By including a programmable divider in the pixel processing computers firmware which handles this timing signal, the signal is able to support variable printing densities in the direction of paper travel.

20   7.   Page Synchronisation

       The pixel processing computer keeps track of page countries for individual layers by using a standard phase lock loop (PLL) mechanism implemented in its software. Each cycle of the PLL's internally generated timing signal corresponds to one or more pages of output. The page synchronisation signal is compared to the internally timing signal and the error is

25   used to advance or retard the internal signal.

       The internal timing signal is used to control the start of image output for each page of each layer. Successful operation results in the chopper cutting continuous paper into sheets at desired page boundaries.

       Furthermore, the PLL also fine tunes the timing of image generation to enable it to track

30   the timing signal from the chopper, and hence suppress any physical deformation effects,

such as stretching, that are temperature and humidity related. By using a real time adjustable phase offset for each layer allows

8.   System Start-up

The software and firmware for the printing pixel processing system and the reconfigerable
hardware is automatically retrieved from the main server by the operator station and passed to the printers computer. The design for a print job, created by a customer using the web-enabled graphics editor, is then retrieved by the operator, and with some additional operator input, used to start the printer. Information such as font data is transferred to the printer using a network connection as needed.

9.   Print Head Power Supply

A computer controller power supply monitors operation of the print head assembly and maintains control of a power up and power down sequences. Should conditions that are considered dangerous to the print heads occur, an immediate shutdown is sequenced.

10.   Print Job Preparation

The image elements on each layer are analysed. The extent of each element in a layer's image is determined so that the print heads that will be active across the paper can be identified. A note is made of image strips that corresponding to heads that will not be used and then the effect output image is shrunk by removing the empty strips and adjusting the image element co-ordinates accordingly. The electronics in the print head assembly is provided with data of which strips of the image data are inactive so that corresponding print heads can be held in their reset state and pixel data corresponding to nothing can be printed need no longer be transmitted to these heads. The individual print head control logic of the remaining active heads is given an image strip or data packet ID to identify the pixel data to be printed. Directing a print head to be held off line reduces wear and power use. Furthermore, it also means that only data packets for the print heads that have been brought on line need to be transferred, thereby removing a potential bottleneck in the system.

The image is outputted onto the paper in scans across the paper flow direction. The print job is rotated t fit and print most efficiently on to the continuous paper stock. To handle this, the image description co-ordinates are transferred as required (eg by rotation and/or

by reflection, and the font information and included images are also retrieved from the main server and similarly transferred.

On the occasions where the width of a print job across the paper is much narrower than the maximum width that can b e printed by the print head assembly, multiple copies of the

5   print job can be outputted side by side as the paper passes under the print head assembly. To accommodate this, the print job elements are duplicated with the new copy or copies having co-ordinates translated across the paper so that duplicates occupy their own section down the paper. Commands specifying how counters and variable text are to be updated after each page is printed are also modified. The use of image duplication

10   reduces the computational load on the system.

The print head assembly shown in fig 2 holds print heads in regular shaped groups currently for example 5 groups of 4 heads. As each of the active heads are configured to print image data with a particular strip ID (or packet ID) number, it is possible to have the same print data used by more than one head at a time. This allows image replication

15   across the paper at no additional computation load.

At system star up time print assembly as downloaded firmware to configure its main electronics and then additional information specifying which image packets each print head is to output.

CLAIMS

1. A method of simultaneously printing multiple paper streams with a combination of fixed and variable information, characterised in that said method comprises the steps of:
-developing page layout information incorporating fixed and variable image information
5   using a web based graphics editor program;
-supplying the page layout information to an image processing computer, said image processing computer including a digital signal processing system adapted to analyse the page layout information into a pixel data corresponding to fixed and variable information to be printed and dividing the pixel data in to a plurality of data packets; and
10   - each of said data packets being delivered to a respective print head in a plurality of print head arrays, wherein a respective print head array corresponds to each layer of paper to be printed.

2.   A method according to claim 1, characterised in that the page layout information is
15   stored on a main server as a print job by a job server program which is adapted to implement a version control scheme and organise storage and updates of designs.

3.   A method according to claim 1, characterised in that the print job information is accessed from the job server at a printer operator station networked to the main server.

4.   A method according to claim 1, characterised in that the printer operator station
20   uses a printer control program operating in a web browser or in a JAVA Runtime Environment.

5.   A method according to claim 3, characterised in that the printer operator station can interrogate the job server via a menu system for a list of jobs to be printed and select a job for printing, the printer operator program prompting the job server to forward the page
25   layout information to the image processing computer and control electronics associated with the print head arrays.

7.   A method according to claim 1, characterised in that, each print head array is mounted on an adjustable platform creating a modular print station.

8.   A method according to claim 7, characterised in that each of the print stations are able to be movably mounted on a monorail so that the print stations can be positioned at any suitable length along a printer.

9.   A method according to claim 8, characterised in that, the print head array is adjustable in two directions, allowing the print station to handle a variety of paper positions.

10.   A method according to claim 7, characterised in that the print head array incorporates a set-release-reset mechanism incorporated into the positioning mechanism for the print head array to thereby allow rapid servicing and precise repositioning of the print head array in the print station.

11.   A method according to claim 1, characterised in that the print head array includes a plurality of inkjet devices, a processor controlled power supply, and an ink supply system.

12.   A method according to claim 7, characterised in that, each of the modular print stations and accordingly the print head arrays has a communications link to the pixel processing computer and an operator station associated with an interactive with the image processing computer.

13.   A method according to claim 1, characterised in that the image processing computer interacts with a main server through a graphical user interface.

14.   A method according to claim 1, characterised in that both the printer operator program and the graphic editor used for the page layout design are programmed using a common programming language to ensure that user interfaces are consistent.

15.   A method according to claim 1, characterised in that he graphic editor allows the creator to assemble up to 8 separate layers for any print job.
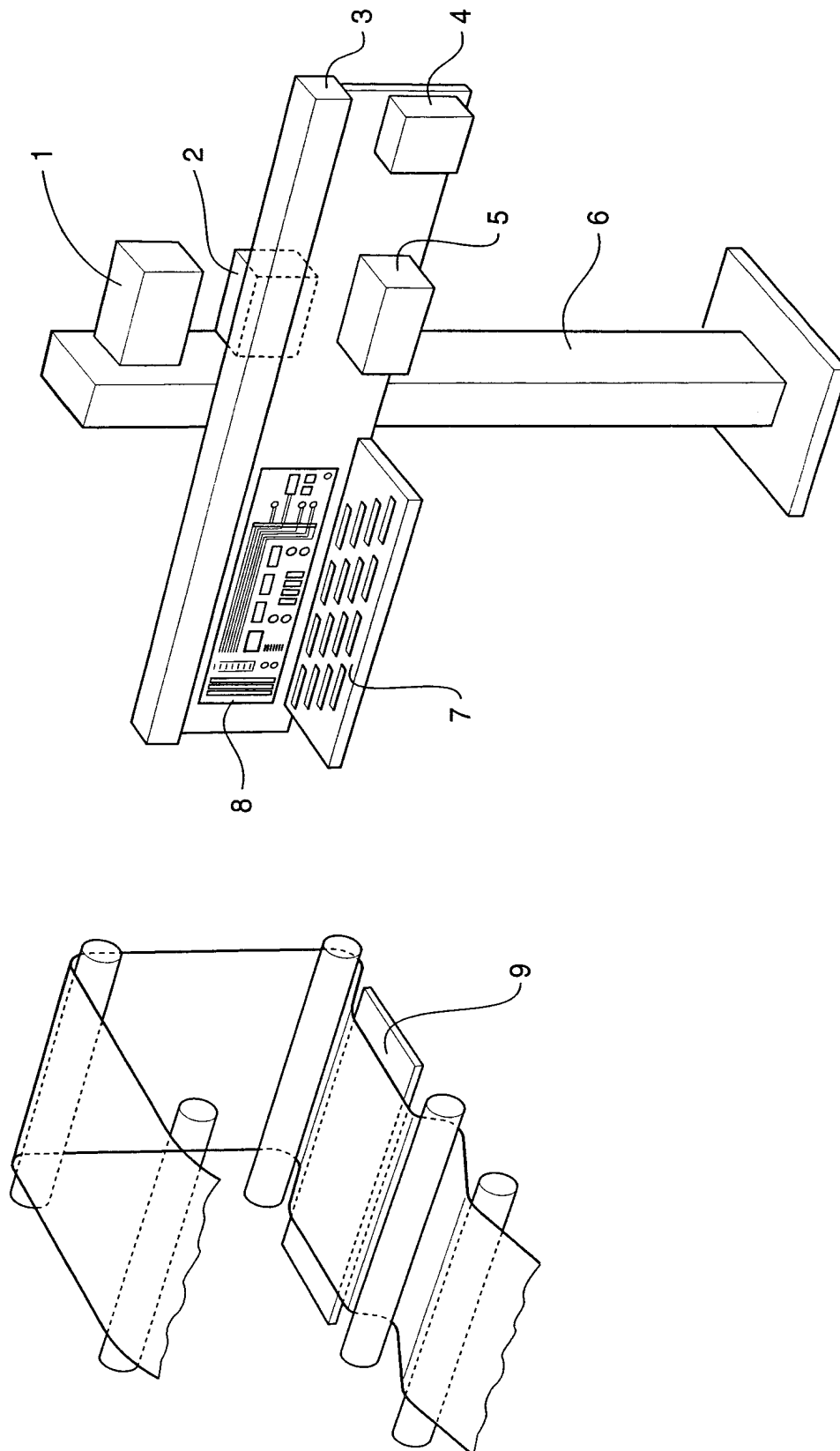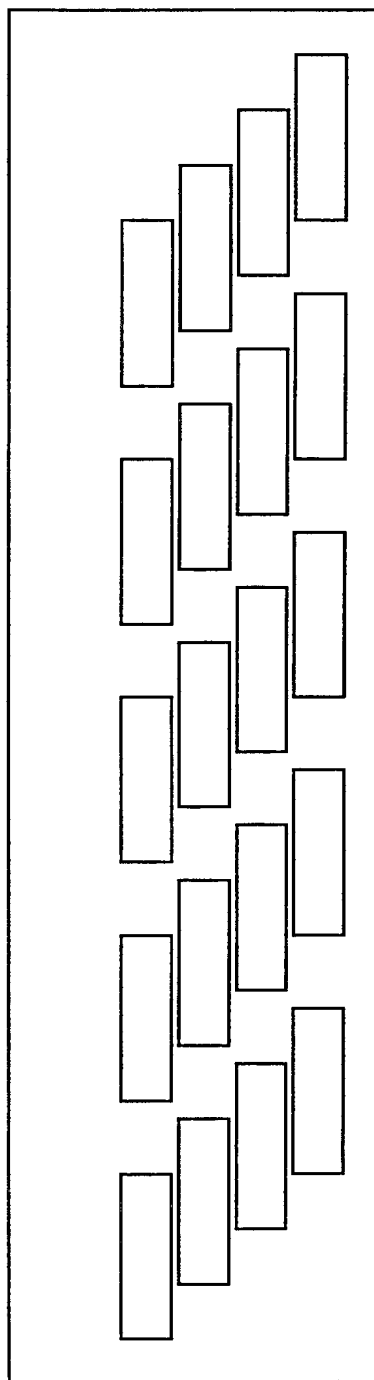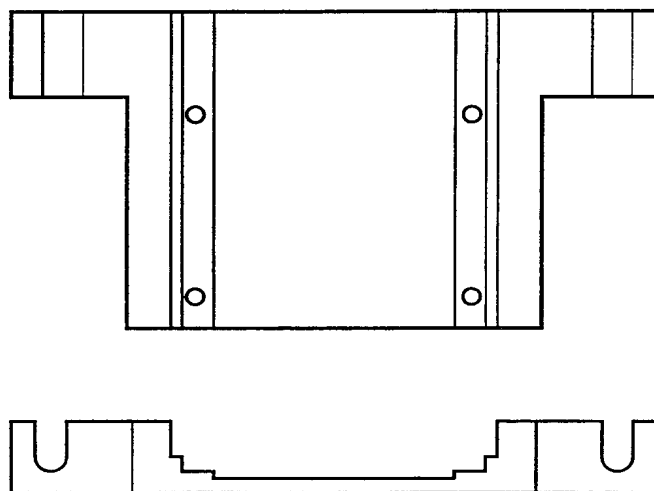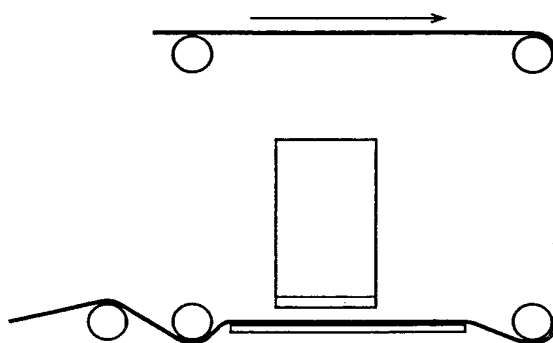
Fig 1

Fig 2

Fig 3

Fig 4

A.	CLASSIFICATION OF SUBJECT MATTER

Int. Cl. [7]:   B41J 29/40, 3/62, G06F 3/12

According to International Patent Classification (IPC) or to both national classification and IPC

B.	FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC: Whole IPC with some search terms, IPC as above with some search terms

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
DWPI: Search terms: Head, printhead, multiple, plural, modular, number, array, more, two, paper, stream, page, sheet, feed, stock, web, roll, strip, printer, web, www, internet, net, wan, B41J 3/62, B41J 29/40, G06F 3/12

C.	DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4495582 A (DESSERT et al) 22 January 1985 See whole document, particularly column 4 line 10-column 5 line 22	1-15
A	EP 837401 A (SCITEX DIGITAL PRINTING INC) 22 April 1998 See whole document	1-15
A	US 5890173 A (YODA) 30 March 1999 See whole document	1-15

☐   Further documents are listed in the continuation of Box C   ☒   See patent family annex

* Special categories of cited documents:	"T" later document published after the international filing date or
"A" document defining the general state of the art which is not considered to be of particular relevance	priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"E" earlier application or patent but published on or after the international filing date	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such
"O" document referring to an oral disclosure, use, exhibition or other means	combination being obvious to a person skilled in the art
"P" document published prior to the international filing date but later than the priority date claimed	"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
20 October 2000	- 6 NOV 2000
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustralia.gov.au Facsimile No. (02) 6285 3929	Authorized officer DEREK BUTLER Telephone No : (02) 6283 2347

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member						
US	4495582	CA	1187193	EP	96564	JP	59002850
EP	837401	CA	2215094				
US	5890173	CN	1159627	EP	775962	JP	9146719

END OF ANNEX